12-bit ADC with I^{2}C™ interface

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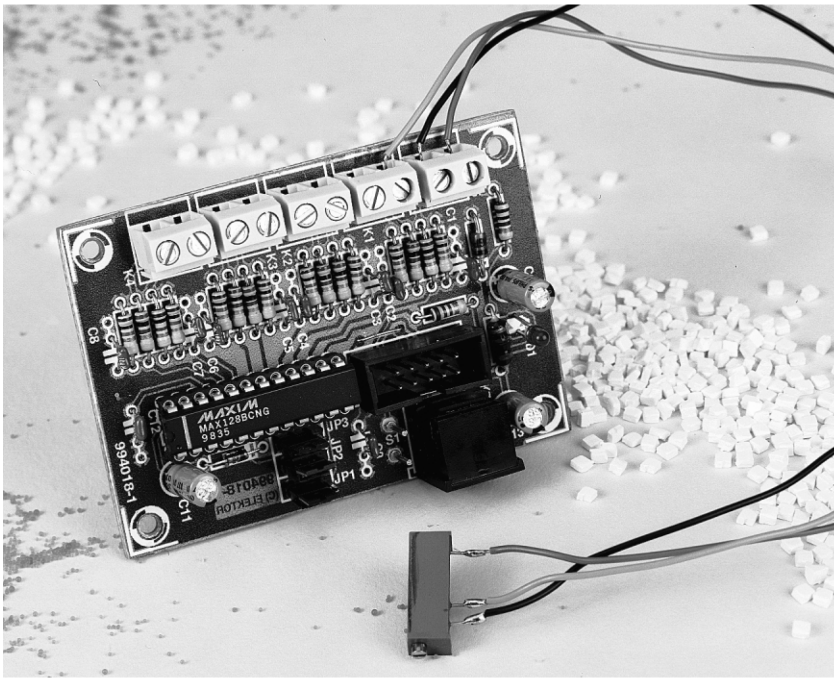
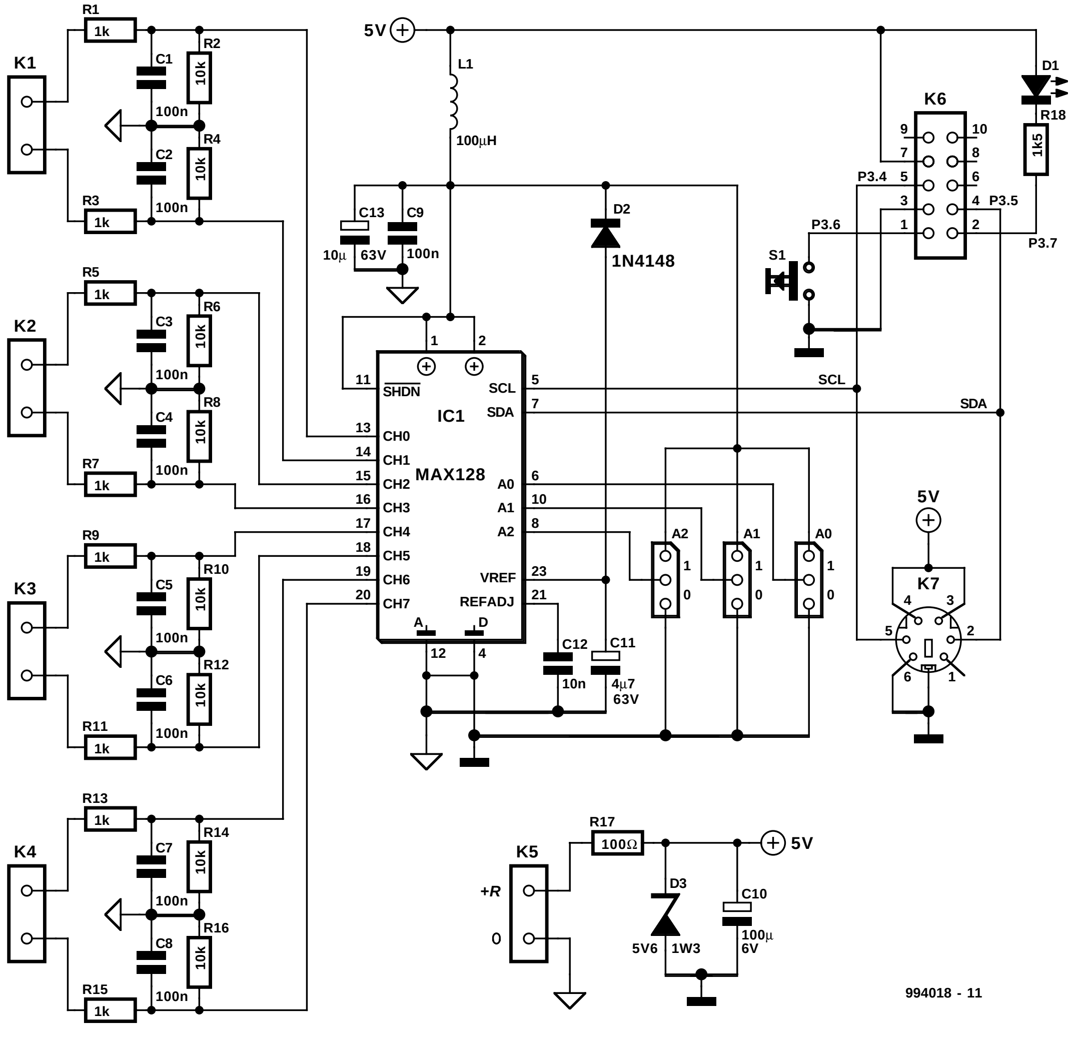
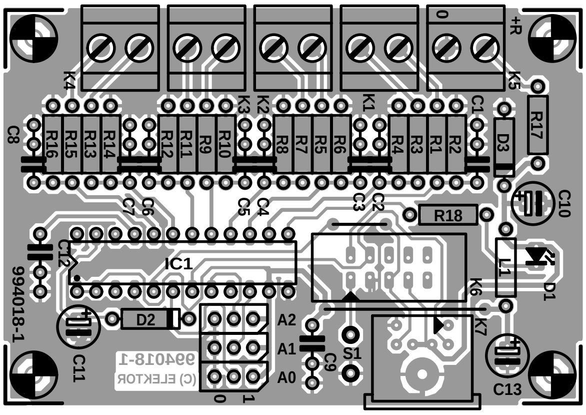
Until not so long ago, only 8-bit analogue-to-digital converters (ADC) offered an I^{2}C™ interface. Unfortunately, a resolution of 256 samples is inadequate for a number of measurements. The 12-bit ADC described in this short article has a resolution × 16 or even × 64 as high. This makes it a lot more convenient to read, say, the usual temperature sensors, such as the LM335, which output 10 mV °C^{-1}. With a 12-bit ADC and an internal reference voltage of 4.096 V, the resolution is 1 mV, which means that the sensor reading can be read in 0.1 °C. With an 8-bit converter, the resolution would be only 1.6 °C.

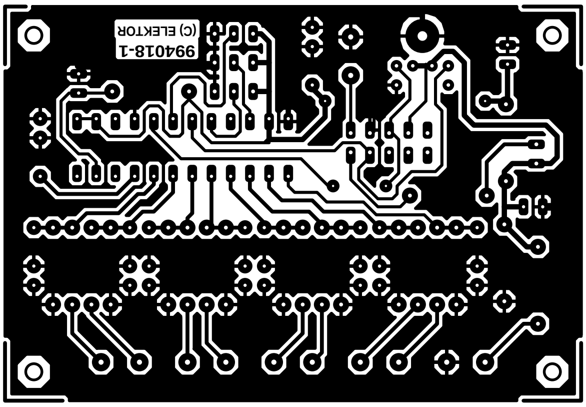
The program given below is written for the Matchbox computer a book about which, *Matchbox BASIC Computer* (ISBN 0 905705 53 X) is available from Elektor Electronics (Publishing).

When START is enabled, the program arranges for an interrupt per second to be produced, which means that a sample is taken every second. At the same time, the liquid-crystal display (LCD) is initialized. The final line sends the result of the print instruction to the LCD; if this and the penulti-









Parts list

Resistors:
R_1, R_3, R_5, R_7, R_9, R_{11}, R_{13}, R_{15} = 1 kΩ
R_2, R_4, R_6, R_8, R_{10}, R_{12}, R_{14}, R_{16} = 10 kΩ but see text
R_{17} = 100 Ω
R_{18} = 1.5 kΩ

Capacitors:
C_1–C_9 = 0.1 µF
C_{10} = 100 µF, 6 V, radial
C_{11} = 4.7 µF, 63 V, radial
C_{12} = 10 nF
C_{13} = 10 µF, 63 V, radial

Inductors:
L_1 = 100 µF

Semiconductors:
D_1 = LED, high efficiency
D_2 = 1N4148
D_3 = zener, 5.6 V, 1.3 W

Integrated circuits:
IC_1 = MAX128BNCG (Maxim)

Miscellaneous:
JP_1–JP_3 = 3-way jumper
K_1–K_5 = 2-way terminal block for board mounting
K_7 = 6-pin mini DIN socket for board mounting
S_1 = push-button switch, 1 make contact
PCB Order no. 994018 (see Readers Services towards the end of this issue)

mate line are ignored, the results are automatically passed to the monitor screen.

After initialization under START, the program is in an endless loop waiting for interrupts. When an interrupt arrives, a byte is sent to the ADC, whereupon the result (2 bytes) is read. Note that this means that the result must previously be declared as an array of two bytes. Subsequently, the cursor of the display is set to the correct position and the result is written to the LCD. The interrupt routine is ended with the instruction IRETURN.

There are two types of ADC: the MAX 127 and the MAX128. In the MAX127, the software allows an input range of 0–10, 0–5, ±10, or ±5 V, to be selected. In the MAX128, these ranges are 0–V_{REF}, 0–$V_{REF}/2$, $\pm V_{REF}$, and $\pm V_{REF}/2$.

The analogue-to-digital conversion is started by sending a byte to the converter: base address 50_H. Bit 7 must be 1, bits 6–4 determine which of the eight inputs is selected; bits 3, 2 determine which input range is chosen, and bits 1, 0 differentiate between active mode (current drain about 10 mA) and power down (current drain 700 or 120 µA respectively).

After the first byte has been sent, the converter may be read by reading two bytes via the I^{2}C. The first received byte is the most significant bit (MSB), and the four highest bits in the second byte contain the lowest significant bit (LSB). The four lowest bits are zero.

Datasheets for the MAX127 and MAX128 may be had via the internet: http://www.maxim-ic.com

The interface is best built on the printed-circuit board, which is available ready made (Order no. 994018) via the Readers Services—see towards the end of this issue.

A final note: if the inputs are used for voltages only, resistors R_2, R_4, R_6, R_8, R_{10}, R_{12}, R_{14}, and R_{16}, may be omitted.

[994018]

I^{2}C is a trademark of the Philips Corporation.

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Listing
; MAX128.MBL
; MAXIM 128 12 BIT A/D TEST
; 08/04/99 BY W

RESOURCE IIC-EEPROM  0100H BYTES @05000H
RESOURCE 8051-IRAM   10H   BYTES @070H

BYTE RESULT[2]                  ; Array for I2C
BYTE CNTRL

START:
  ON INT GOSUB CONVERSION
  TIMER(0,0)                    ; Stop Timer
  TIMER(192,4800)               ; Start Timer 1s interval
  SETBITS(INTena,TIMena)        ; Enable interrupts and Timer interrupt
  LCDSET                        ; Init LCD
  FORMAT(LCD D U LENGTH=5 Z l)  ; Output to LCD, decimal, no sign, 5 digits

LOOP:                           ; Endless loop
GOTO LOOP

CONVERSION:                     ; Interrupt routine every 1s
  CNTRL:=10001000B              ; Start A/D conversion, input 0, 0..Vref
  IICWR(01010000B,1,CNTRL)      ; Write to A/D
  IICRD(01010000B,2,RESULT)     ; Read two bytes (msb & lsb)
  LCDCOM(128)                   ; Position cursor LCD
  PRINT(RESULT[0]*16+RESULT[1]/16) ;

  CLEARBITS(TIMint)             ; Reset timer interrupt flag.
IRETURN                         ; Return from timer interrupt

END
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